

Surface Acoustic Wave (SAW) based Biosensor Chips: A versatile solution for Future Biomedical Applications

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**Surface Acoustic Wave (SAW) based Biosensor Chips:
A versatile solution for Future Biomedical
Applications**

G. Blaess, K. Länge, M. Rapp

Forschungszentrum Karlsruhe, Institute for Instrumental Analysis
P.O. Box 3640, 76021 Karlsruhe, Germany

SAW devices basing on horizontally polarized surface shear waves (HPSSW) enable label-free, sensitive and cost-effective detection of biomolecules in real time. Due to their high operating frequencies, SAW sensors have the highest sensitivity of all gravimetric methods. Binding reactions on the sensor surfaces are detected by determining changes in surface wave velocity caused mainly by mass adsorption or viscosity changes in the sensing layer. To create a biosensor, SAW devices were coated with several layers to promote covalent binding of biochemical receptors [1]. Early results showed the importance of small sampling volumes with low inner surface areas [2]. Especially, the use of bond wires is critical. Beside their instability in liquid streams they severely prevent small sampling cells. In addition, a minimum of mechanical stress by fixing the device is required. The latter is hard to solve since sealing elements usually require a minimum of pressure. This results in a rather inaccurate sensor calibration strongly affected by the pressure of the sensor fixation. The main reason for this are different capacities of the dielectric coupling resulting in a constant but different phase position of the sensor within its oscillator. From earlier work we knew that exactly this effect is critical [3].

A new approach avoids this drawback and enables a remarkable higher level of miniaturization: The sensor device is completely packed within a polymeric housing produced by stereo lithographic methods. The result is a polymer chip shown in fig. 1 as a tight and durable package for SAW biosensors. The chip encapsulates the SAW device leaving the back side of the SAW device open. This concept was followed to ensure good mounting of SAW device into the polymer chip. Fig 2 shows the upper side of the polymer chip leaving only a small flat channel open along the SAW path. The effective sample volume is only 500 nl per chip! Electric contact of the SAW device is made by evaporated conductive paths buried within the chip. They lead to large pads on the chip surface to be contacted from outside with corresponding pads on the circuit board. These SAW biosensor chips are widely insensitive towards mechanical influences or phase position changes due to a durable encapsulation, a minimum of applied mechanical stress and the use of pure ohmic contacts. First measurements applying these sensor chips resulting from adsorption phenomena and immunosensing experiments with bioactive molecules will be shown. See an example in fig. 3. Furthermore a new concept will be presented which extends this technology towards 4 (see fig 4) and even 8-fold sensor arrays.

References

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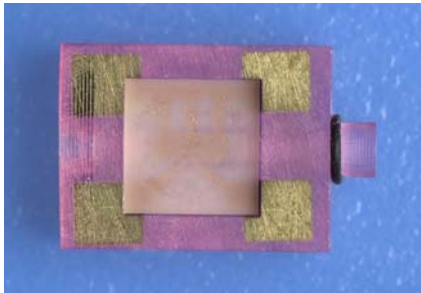


Fig. 1: SAW biosensor place into a plastic chip as a tight and durable package. The encapsulation of the SAW device leaves the back side of the SAW device open.

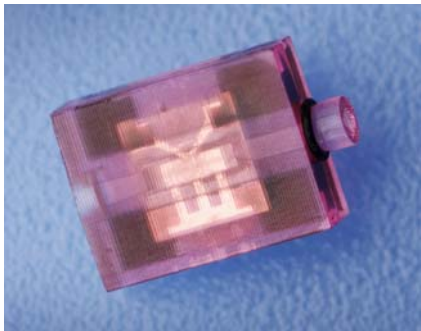


Fig. 2: Upper side of the polymer chip leaving only a small flat channel open along the SAW path. The effective sample volume is only 500 nl per chip!

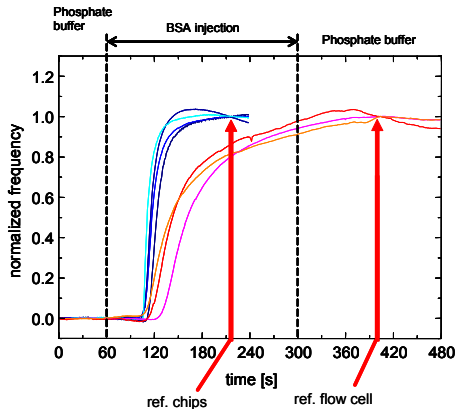


Fig. 3: Normalized frequency responses of several SAW biochips (blue curves) compared to an old configuration (red curves) where the sensor is placed by hand into an adapter for measurement. Obviously the smaller volume of the chip (500nl) allows faster sensor response compared to the old configuration having a volume of 5µl.

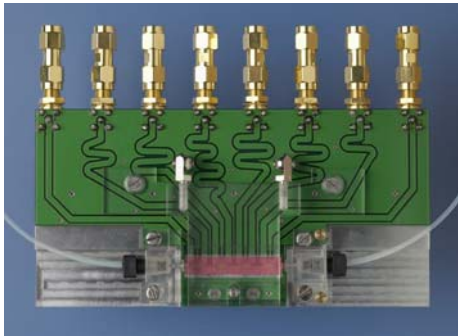


Fig. 4: Prototype of a 4 fold SAW biosensor array with high frequency SMA connectors above and tubing of sampling liquid at lower left and right. The SAW biochip array itself is the pink section of the lower part of the photo.